cultures, but chief interest centers in the spore-formation. Under special nutritive conditions ("starvation") two neighboring cells put out beaks towards one another, which meet and fuse by their tips. The "compound cell" thus formed appears as two ordinary cells attached to one another by an elongated neck. "A few hours after fusion, in each compartment of the compound cell" the spores begin to round off. The author also obtained appearances that he interprets as fusion of the "nuclear apparatus" in the connecting tube. He discusses the various possible interpretations, but concludes that this phenomenon is a sexual process of the simplest kind. He also proposes a new genus to include this form, and suggests the name *Zygosaccharomyces*. What constitutes sexual fusion, as distinct from other fusions, is a question that is becoming increasingly difficult to answer.—J. M. C.

NOTES FOR STUDENTS.

CZAPEK shows[10] that the well known transformation of starch to sugar, which accompanies a lowering of temperature, especially in autumn, can be prevented if the sugar concentration is sufficient. Starch was also formed in guard cells of certain plants immersed in a 10 per cent. cane sugar solution at a temperature of 0°.—H. C. COWLES.

TUCKER and TOLLENS,[11] also Fruhwirth and Zielstorff,[12] have taken up the question of the autumnal migration of carbohydrates, proteids, phosphoric acid, and potash from the dying leaves to the perennial stems of plants. The works of Wehmer and Behrens have given rise to a disbelief in such migrations, Behrens attributing losses of these substances to decomposition and leaching out by rain water. The present authors, however, guarding against such processes, conclude that there are fall migrations of useful substances, though the amount of translocated material is very much less than was once believed.—H. C. COWLES.

D. A. ANDREWS has been investigating karyokinesis in the pollen mother cells of Magnolia and Liriodendron.[13] His conclusions in reference to the first mitosis are that the chromosomes arise from the resting nucleus as irregular masses, without a previous formation of the usual uniform spiral, that the resulting chromosomes are mostly U-shaped, and that they divide longitudinally. The identity of the chromosomes, therefore, is not maintained from the first to the second mitosis, the chromosomes in the latter case arising by the segmentation of an irregular spirem and being at first lumpy bodies that assume the form of a shallow U.—J. M. C.

[10] Ber. d. deutsch. bot. Gesell. **19**: 120–127. 1901.

[11] Jour. für Landw. **48**: 39–64. 1900. [12] Landw. Versuch. Stat. **55**: 9. 1901.

[13] Karyokinesis in Magnolia and Liriodendron, with special reference to the behavior of the chromosomes. Bot. Centralb. Beih. **11**: 134–142. *pl. 1.* 1901.

HATTORI[14] has added another to the numerous contributions on the toxicity of copper. Seedlings of several conifers growing in pots endured much more copper than branches in aqueous solutions. Moist air, by decreasing the transpiration, enabled plants to endure a greater concentration in the water—according to very meager experiments. The copper in water distilled from copper vessels was found sufficient to kill roots. The growth of Aspergillus and Penicillium was stimulated by dilute copper; in the case of Aspergillus this did not interfere with the formation of conidia. In all cases the concentration of copper is given in the extremely inconvenient form of a per cent. of $CuSO_4 + 5H_2O$.—E. B. COPELAND.

BENECKE[15] has reinvestigated Cakile and Salicornia in order to test the recently expressed view of Diels that these plants decompose considerable quantities of NaCl in their metabolic activities. Diels observed gradual decrements of salt in distilled water cultures, especially in Cakile, and he supposed that sodium malate, or some such substance, was formed, setting free the chlorine. Benecke thinks that Diels failed to account for the increase of other substances, especially water, in his plants, and that consequently his percentage comparisons were wrong. The present author uses similar methods, and concludes that the chlorine content suffers no decrease in distilled water cultures. Apparent decrease may be due to increase of water, as noted above, and also to variations in chlorine content in leaves of different ages, the old leaves being relatively poor in NaCl.—H. C. COWLES.

IN A RECENT PAPER, Professor Guignard[16] has described the details of of double fertilization in *Naias major*, which do not differ essentially from those in other forms recently described. The male nuclei are elongated, but do not take on the vermiform appearance so conspicuous in the Compositae. One synergid disintegrates soon after the entrance of the pollen tube, and the other remains intact for some time after the fertilization of the egg, and may itself be fertilized instead of the endosperm nucleus. In the latter case the endosperm does not develop. The fertilized egg immediately divides, one figure showing the fertilized endosperm nucleus in the spirem stage, while the embryo is two-celled. In all previously described cases of double fertilization the endosperm nucleus invariably divides before the fertilized egg shows any signs of division. In many instances two embryos were observed side by side, with the unfertilized endosperm nucleus lying between them. Two of the antipodals soon show signs of breaking down, but the upper one

[14] Studien über die Einwirkung des Kupfersulfats auf einige Pflanzen. Jour. Coll. Sc. Imp. Univ. Tokyo **15**: 371–394. 1901.

[15] Jahrb. für wiss. Bot. **36**: 179–196. 1901.

[16] La double fécondation dans le *Naias major*. Jour. de Bot. **15**: 1–9. *figs. 1–14.* 1901.

continues to enlarge for a long time after fertilization. The chromosomes are very long, the gametophyte number being six, the smallest number yet reported in seed-plants.—W. J. G. LAND.

INVESTIGATIONS dealing with the influence of the medium on plant development continue to multiply. Pethybridge[17] has experimented with various salt solutions on the development of wheat, finding that the dilution of nutrient solutions or the addition to them of NaCl causes root elongation, decrease in leaves, shoots, and root diameter, and increase in the thickness of endodermis walls; the stomata on the under leaf surface almost wholly disappear. Root hair formation is repressed in NaCl solutions and in increased light. Arker[18] finds that the rapidity of growth of the roots of *Lupinus albus* is facilitated by introducing air currents, especially if somewhat rarefied, into the medium. Beauverie[19] found that an increase of osmotic pressure caused a reduction in the aerial portions of fungi, together with a lateral dilatation of the cells; in very strong solutions the entire plant often became submerged. A more recent study of various seed plants has yielded similar results. Beauverie refers the well known root curvature in water to differences in osmotic pressure rather than to aerotropism, finding that the roots grow straight down in concentrated solutions. The aerial axis becomes reduced in height and broadened laterally as in fungi. The anatomical structure is affected also; a thick cork layer is developed very early in strong solutions; but this is not the case where the pressure is weak.—H. C. COWLES.

BERNARD[20] has presented to the Paris Academy of Sciences two papers which will be certain to incite interest and further investigation. In the first paper, entitled precocious tuberculization in plants, he recalls the production of tubercles on legume roots and coralloid processes on various tree roots through stimulation by bacteria and fungi. Bernard shows the remarkable resemblance between the tuberculous organs of lycopods and orchids, two widely separated families. The gametophyte and sporophyte of Lycopodium and the sporophyte of several orchids show essentially similar organs, and are infested by similar fungi, and in all cases the fungus is Fusarium or a related form. Of a large number of tuberous plants investigated by Stahl in his recent mycorhiza studies, Corydalis alone is found to be without fungi. In his second paper Bernard makes the surprising statement that it is his belief that the tubers of the potato are essentially galls and due to fungus infection. He shows that *Fusarium Solani* is always present in the tubers, and it seems likely that this fungus causes the arrest of the terminal bud and

[17] Inaugural dissertation. Göttingen. 1899. (See Bot. Centralb. **87**: 235. 1901.)

[18] Inaugural dissertation. Erlangen. 1900. (See Bot. Centralb. **87**: 235. 1901.)

[19] Compt. Rend. **132**: 226–9. 1901.

[20] Compt. Rend. **131**: 626–629. 1900; **132**: 355–357. 1901.

the development of hypertrophied tissues, which become filled with starch. The author's experiments, while not yet conclusive, strongly support his theoretical conclusions, since a decided parallelism is seen to exist between the amount of tuber formation and the development of the fungus. However, no cultures entirely free from fungus have yet been made. Bernard notes than when the potato was introduced into France, tubers could not be produced from seed cultures, presumably because *Fusarium Solani* did not then infest the soil.—H. C. COWLES.

TANSLEY and CHICK[21] have made some interesting anatomical studies on the conducting tissue system of bryophytes. The main purpose of the investigation was to shed light on the probable origin of conducting tissues in plants. In general the authors confirm the work of Haberlandt, who showed that the Polytrichaceae have a more complex conductive system than some so-called vascular plants. The tracheids of the liverwort Pallavicinia were studied and were shown to conduct eosin solutions more rapidly than neighboring tissues, though much more slowly than Haberlandt found to be true in moss bundles. The rhizome of Polytrichum was found to have structures resembling the roots of seed plants, viz., a typical endodermis with suberized walls, a pericycle, and a central cylinder with a triarch arrangement of the hydroids and leptoids. It would seem from this that the rhizome of Polytrichum may well be called a root. The aerial stems were found to agree with Haberlandt's description. The authors think from the liverwort evidence that demands for more efficient conduction were first met by cell elongation and lignification of the walls. This idea is favored also by experimental evidence, as has been often shown. In most mosses the leaf and stem bundles are not connected, indicating a possible double origin of conducting bundles. Mnium and Bryum show incomplete connections, while Polytrichum and its allies show bundles of hydroids and leptoids permeating the entire plant, as in ferns and seed plants. In Polytrichum there is a hydrome mantle outside the central cylinder of leptome and hydrome, in this respect resembling ferns. The authors think that this outer mantle may be the downward projection of the leaf bundle, the original stem bundle being at the center.—H. C. COWLES.

THE STRUCTURAL DIFFERENCES between the white and green parts of variegated leaves has been recently noted.[22] The general subject of the "panachirung" (perhaps this term may be rendered into English as "albescence") of leaves has had considerable investigation of late. Timpe[23] finds that the anatomical features are much as noted in the review of Rodrigue's paper; in some cases (as Abutilon) the albescent portions are thicker than the

[21] Annals of Botany **15**: 1–38. 1901.

[22] BOT. GAZ. **31**: 209. 1901.

[23] Inaugural dissertation. Göttingen. 1900. See Bot. Centralb. **85**: 75. 1901.

green portions of the leaf. Thin albescent parts are due to a reduction in palisades and intercellular spaces. The author finds a close relation to exist between chlorophyll development and leaf thickness, including the development of palisade cells; if chlorophyll stops abruptly in a variegated leaf, the thin part begins abruptly and palisades cease at once; if the chlorophyll fades out gradually, the leaf gradually becomes thinner and palisades gradually cease. These results and those of Rodrigue seem to throw doubt on Stahl's theory that palisades are due to the direct influence of light, and relate them rather to the presence of active synthesis; the reviewer, however, has observed palisade cells in the albescent parts of many leaves. Timpe finds that albescent portions of leaves redden more than the green portions; this harmonizes well with Overton's conclusions,[24] since the white leaf parts are found to be rich in tannins and sugars, though poor in starch.

Laurent,[25] discusses the origin of albescence in plants. There are two types, those coming from spores, and those that reproduce by seed. The latter type is ordinarily thought to be not responsive to external factors. In some situations plants which are commonly albescent have green leaves, and in other situations the reverse is the case. Laurent thinks that some enzyme intervenes to cause a modification in the distribution of the chlorophyll.

Molisch[26] observed that *Brassica oleracea acephala* becomes albescent in cold greenhouses in winter, and becomes green again in summer, the whitening beginning in October and reaching its maximum in February. The author thus holds with Laurent that albescence may be affected by external factors. In the case of Brassica the author thinks that temperature is the factor involved, since warm greenhouse cultures do not show the phenomenon.—H. C. COWLES.

ITEMS OF TAXONOMIC INTEREST are as follows: F. STEPHANI (Bull. Herb. Boiss. II. 1: 1141. 1901) has segregated a new genus (*Cuspidatula*) of liverworts from Anastrophyllum, the 4 species included belonging to the East Indian and Australian region.—B. L. ROBINSON (Rhodora **3**: 270–276. 1901) has published a synopsis of the North American species of *Euphrasia*, recognizing 7 species, 2 of which are new (*E. Williamsii* from Mt. Washington and *E. Randii* from Mt. Desert.)—THEO. HOLM (Ottawa Nat. **15**: 175–183. *pls. 11–14.* 1901) has described 3 new Canadian species of *Gentiana* belonging to § Crossopetalae.—S. B. PARISH (Proc. Calif. Acad. Sci. III. Bot. **2**: 159–172. 1901) has revised certain troublesome species of *Solanum* of the *S. Xanti* and *S. umbelliferum* group, describing 3 new species and 4 new varieties, and giving detailed lists of collections.—HELGI JÖNSSON (Botanisk Tidsskrift **24**: 127–155. 1901) has published an account of the Rhodophyceae as the first of a series of papers on the marine algae of Iceland, 2 new species

[24] BOT. GAZ. **27**: 491. 1899. [25] Bull. Soc. Roy. Bot. Belg. **39**: 6–9. 1900.

[26] Ber. deutsch. bot. Gesell. **19**: 32–34. 1901.

being described.— JOHS. SCHMIDT (*idem* 157–221. *pls. 2–4*) has published Part IV of his *Flora of Koh Chang* (Gulf of Siam), W. and G. S. WEST contributing the fresh water Chlorophyceae (121 spp., 9 new), TH. REINBOLD the marine algae (62 spp., 2 new), M. GOMONT the Myxophyceae hormogoneae (27 spp., 2 new), and JOHS. SCHMIDT the Peridiniales (44 spp.), *Ostreopsis* being a new genus.— F. V. COVILLE (Proc. Wash. Acad. Sci. **3**: 569–576. 1901) has segregated two new genera from Cassiope, *Harrimanella*, containing *C. stelleriana* DC. and *C. hypnoides* D. Don, and *Arcterica*, containing *C. oxycoccoides* Gray.— P. A. RYDBERG (Bull. Torr. Bot. Club **28**: 605–643. 1901) has published a monograph of the American species of *Limnorchis* and *Piperia*, both genera having been separated by him from Habenaria, in the former genus 24 species being recognized (5 new), and in the latter 9 (3 new).— G. E. OSTERHOUT (*idem* 644–645) has published new species of Linum, Mentzelia, Artemisia, and Agoseris from Colorado.— A. ENGLER (Bot. Jahrb. **30**: 289–445. *pls 9–22*. 1901), in continuing his studies of the African collection of W. Goetze, has published, in addition to numerous new species, a new genus (*Stenadenium* Pax) of Euphorbiaceae.— RUDOLF WAGNER (Œsterr. Bot. Zeitsch **51**: 465. 1901) has described a new genus (*Cyphochlaena*) of grasses from Madagascar, of the tribe Arundinelleae.— J. M. C.

THOMAS[27] has made a comparative and experimental study of subterranean leaves or scales. They correspond morphologically to sheaths, petioles, or leaf blades, and in all cases differ widely from their morphological homologues. This divergence is particularly great where scales correspond to leaf blades, the palisades, lacunae, bundles, mechanical cells, and epidermal cuticle being much reduced or absent. When aerial branches are made to grow in the soil, leaf primordia develop into structures whose anatomy is like that of scales; leaf blades are reduced, petioles are less reduced, or sometimes even greatly enlarged as in Trifolium, channeled petioles change to flat organs, collenchyma and bundles are reduced, the parenchyma is more compact and with polygonal, instead of rounded cells. The upper epidermal walls are less cutinized, and the lower walls more cutinized, than in normal leaves, stomata are entirely lost, palisades and air spaces are reduced, and reserve foods are stored in abundance. When subterranean branches are made to grow in the air, scale primordia develop into leaves, stomata appear, palisades, vascular tissues, and air spaces are more fully developed.

Some very interesting conclusions are drawn by the author. The scale is found to be the morphological equivalent of the leaf part nearest the base, *i. e.*, the blade in a sessile leaf, the petiole or sheath in a petioled leaf. The changes observed are quite different from the effects of mere darkness, nor are they to be attributed to arrested development, since they differ widely

[27] Rev. Gen. Bot. **12**: 394–404, 417–433. 1900.

from early leaf conditions. The reductions in palisades, air spaces, bundles, and collenchyma are analogous to conditions in young leaves, or to leaves grown in the dark (though the reduction is more complete in the soil); but the entire loss of stomata, the great development of reserve foods, and the strong cutinization of the lower epidermis are without a parallel in other conditions than those furnished by a sojourn in the soil. In some cases, notoriously in *Lysimachia vulgaris*, palisades appear in all conditions, even in leaf primordia while still in the bud and four or five centimeters below ground. The author consequently inclines to agree with Pick that palisades are due to hereditary influences, and that their direction only is determined by light. Thomas also thinks that the changes produced in soil conditions are in direct response to the new needs which arise there.— H. C. COWLES.

STRASBURGER,[28] in a very comprehensive paper, has taken up the whole subject of protoplasmic continuity in plant cells. He proposes the term *Plasmodesmen* for the connecting fibers. Among others, new observations are figured and described for Viscum, Pinus, Phytelephas, Nerium, the sieve tubes of Wistaria and Vitis, leaf cells of mosses, and the cells of grafts of Abies and Picea. But the paper is devoted fully as much to a critical résumé of the literature as to the recording of new observations. To recapitulate all the points made is plainly impossible in a brief review, and only a few of the most important will be mentioned. Kienitz Gerloff's view that the *Plasmodesmen* do not originate in the fibers of the central spindle is confirmed, and they must hence arise secondarily after cell division, but the question as to just how and when they are formed is left unsettled. Figures are given from Pinus and Wistaria confirming the prevalent belief that the thicker connecting strands of the sieve tubes originate as *Plasmodesmen*. As to the functions of *Plasmodesmen*, Strasburger confirms Gardiner's view, that in the endosperm of Tamus they serve to transport enzymes. In the medullary rays of Abies they may serve to transport proteids. That protoplasmic streams in general, however, pass through the fibers, or that they serve, for example, for the withdrawal of protoplasm from the leaves in the fall, is shown to be entirely unproved. The importance of the *Plasmodesmen* for transmitting stimuli and for the normal development of organs is shown by a number of very interesting observations and experiments. Complete plasmolysis results in the withdrawal of the *Plasmodesmen* from their pores in Mnium. Though when washed out the plasmolyzed cells again press upon the cell walls, the *Plasmodesmen* are not reestablished, and the tissue, although it may live several weeks, develops no further and ultimately dies. Plasmolyzed root tips of *Vicia Faba* cannot afterward react geotropically. This may be due to the loss of the *Plasmodesmen*, or to injury of the

[28] Ueber Plasmaverbindungen pflanzlicher Zellen. Jahrb. wiss. Bot. **36**: 493–610. *pls. 14–15*. 1901.

young cell walls. The existence of *Plasmodesmen* between the symbiont cells in grafts of Abies and Picea is shown conclusively. Such facts as that a grafted shoot does not produce roots at its base, and that a grafted lateral twig may bend up and replace a lost central shoot, are doubtless due to morphaesthesia, the stimuli being transmitted through the *Plasmodesmen* of the graft. The question as to whether the *Plasmodesmen* involve continuity or only contact of fibers sent out from adjacent cells is fully discussed, but owing to technical difficulties the facts in the case remain undiscovered.—* * *.

HUGO MIEHE[29] has recently investigated certain cases of nuclear migration in the epidermal cells of some monocotyledons. The fact of the polarity of the epidermal cells that form stoma mother cells had been established by the researches of Strasburger,[30] and more recently by those of Miehe[31] himself. Miehe now finds that by subjecting leaves of *Allium Cepa* or *Hyacinthus orientalis* to a great centrifugal force (2500 × gravity), with the basal ends of the leaves directed outward on the centrifugal machine, the polarity of the cells is exactly reversed, *i. e.*, the stoma mother cells are formed in the basal rather than in the distal part of the epidermal cells. By making stationary the tips of some leaves, to the bases of which small parts of the bulbs were left adhering, and allowing them to grow for some time under favorable conditions, the consequent change in the direction of cell growth produces a corresponding change in their polarity. Miehe thinks that the direction of cell growth is the important factor in determining the position of the stoma cell under ordinary conditions.

Perhaps the most interesting part of the paper, however, is the account of the migration of the nuclei from cell to cell, a process that Miehe found to occur as a response to the stimulus produced by wounds. In such cases the nuclei migrate toward the wounded cells, and when they come near the cell walls put out fine processes that protrude through minute pores in the wall. The whole nucleus passes through such a pore and forms a dense mass on the opposite side of the wall. From the fact that in material killed in Flemming's fluid and stained with the triple stain the denser part of the nucleus (including the pointed processes and the part that has already passed through the wall) stains red, while the less dense part stains blue, Miehe supports Fischer's contention that differentiation in staining is due largely to differences in physical rather than chemical structure of the various

[29] Ueber Wanderungen des pflanzlichen Zellkernes. Flora **88**: 105–142. *pl. 11.* 1901.

[30] Ein Beitrag zur Entwickelungsgeschichte der Spaltöffnungen. Jahrb. wiss. Bot. **6**: 301. 1866.

[31] Histologische u. experimentelle Untersuchungen über die Anlage der Spaltöffnungen einige Monokotylen. Bot. Centralb. **78**: 321, 353, 385. 1899.

bodies. Both the enucleated and multinucleated cells formed by the migration of the nuclei generally die. The neighboring cells then grow into the region thus left vacant. The nuclei generally wander to that part of the cell wall where it is growing most rapidly.

The paper constitutes a very suggestive contribution to a comparatively new field in physiological research. All the material experimented upon was afterwards killed in Flemming's or Carnoy's killing fluid and stained with the triple stain. Such a combination of experimental and histological technique is to be commended as a method by which in many cases more accurate results in the study of the physiology of the cell may be acquired than by the use of either method alone.— H. G. TIMBERLAKE.

TEODORESCO[32] has published some valuable organographic results that should have been noted sooner. The topic of the first paper is the influence of different luminous radiations on form and structure, and the author makes general conclusions of a very satisfactory nature. He finds that in all cases blue light acts most like white light, and green most like the dark, while red light is intermediate. For example, leaves show a maximum of surface in blue light, and a minimum in green, while stems elongate most in green light and least in blue. Some leaves (as in the Crassulaceae) and most petioles agree with stems. Petioles that elongate most in blue light elongate more in white light than in the dark. Palisade cells, chloroplasts, conductive cells, and bark develop best in blue light, least in green. Some roots elongate more in white light than in the dark, of others the reverse is true, while still others are neutral. Blue light, as compared with green light also shows roots to be of three classes. The author holds that blue light increases synthetic energy as compared with red or green light.

The second paper[33] treats of the indirect action of light on stem and leaf. The author grew plants wholly in the light, wholly in the dark, and partly in the dark, hoping to settle as between the view of Sachs that leaves can develop fully in the dark if well nourished by means of other leaves in the light, and the view of Frank and others that light has no such indirect influence. Most experiments confirmed Sach's well-known investigations, leaves growing to a greater size in the dark if other leaves on the same plant were in the light; the leaves were also thicker, and the bundles, mechanical tissues, palisades, and epidermis more developed than on plants wholly in the dark. The stems were longer in partly lighted plants than in either of the other cases, thus agreeing with Sachs. In several lianas, however, Teodoresco finds with Frank that indirect light differs in no respect from total darkness.

In a third paper[34] Teodoresco gives the results of his studies on the

[32] Ann. Sci. Nat. Bot. VIII. 10: 141–263. 1899.

[33] Rev. Gén. Bot. 11: 369–397, 430–435. 1899.

[34] Rev. Gén. Bot. 11: 445–470. 1899.

influence of carbon dioxid on form and structure. Plants were grown in atmospheres almost without carbon dioxid, also in atmospheres containing about 2 per cent. of this gas. Marchantia cultures with but little carbon dioxid showed great reduction in the width and length of thallus, as compared with normal plants; no gemmae were formed, neither the characteristic algoid chlorophyll tissue. Air spaces and chloroplasts were much less abundant, but the colorless parenchyma developed normally. The results are almost exactly those of weakened light. In seed plants Teodoresco finds that so long as seedlings are using reserve foods carbon dioxid retards stem elongation. In older plants carbon dioxid favors the elongation of stems, the enlargement of leaf surfaces, and the rich development of bast, wood, palisades, and air spaces.— H. C. COWLES.

SEVERAL PAPERS have appeared which add considerably to our knowledge of the physiological ecology of chlorophyll and carbohydrate synthesis. Among these the most important are by Griffon. The first paper[35] deals chiefly with the relations between color and the synthesis of carbohydrates. Griffon shows that, although a general ratio exists between the amount and color of the chlorophyll and the amount of CO_2 which is broken up, in many cases the chlorophyll present is no measure of the chlorophyll function; for example, in alpine plants the synthesis is greater and in halophytes it is less than the amount of chorophyll would lead one to expect. This result confirms the previous work of Bonnier, and is contrary to the view of Pfeffer. In some green half-parasites and symbiotic saprophytes the gas exchanges associated with respiration are actually greater than those associated with carbohydrate synthesis. The significance of these results is not clear, but the author holds that differences in the cell structure of the chlorenchyma explain some cases. Perhaps the most rational theory, however, is that there are several varieties of chlorophyll, some possessing active synthetic powers and others not; this view agrees with recent spectroscopic studies by Etard, who claims to have found a large number of varieties of chlorophyll, and sometimes two or three in one plant species.

Another interesting set of results has to do with the influence of colors other than green on the synthetic processes. Stahl, Pick, and others have held that the red anthocyan colors favor synthesis, whereas Jumelle and Jönsson have held that they retard it. Griffon thinks that they have no influence whatever. Although red leaves commonly do less chlorophyll work than green leaves in related species, this is due to the generally smaller amounts of chlorophyll in red leaves. Red leaves rich in chlorophyll are as active as green leaves of the same or similar species. Nor does the author regard anthocyan as prejudicial in chlorophyll formation, even though red leaves are so

[35] Ann. Sci. Nat. Bot. VIII. 10: 1–123. 1899.

frequently poor in chlorophyll. Griffon agrees with Overton [36] that the autumnal colors are due to excessive carbohydrate concentration in the chlorenchyma. He also holds with Bonnier that the synthetic power of xanthophyll is relatively inconsequential. The influence of various external factors on carbohydrate synthesis is well presented but must be omitted here, except to state that Griffon finds that chlorophyll formed in the dark (as in conifer seedlings) acts normally. In this connection it may be noted that Bouilhac [37] has found chlorophyll in Nostoc by spectroscopic tests and has succeeded in observing the formation of chlorophyll in this form in the dark, when it is fed with carbohydrates, such as glucose. Griffon thinks that the development of chlorophyll in the dark is in all cases associated with a supply of reserve foods.

In his second paper [38] Griffon measured the amount of carbohydrate synthesis in solar light which has traversed one or more leaves. That certain light rays are cut off in traversing leaves is well known, but few previous attempts have been made to measure synthesis. Nagamatz used the starch method, which is now known not to be accurate. Griffon uses the gas method, and finds that active synthesis takes place in the second leaf even where light has traversed a thick and densely green leaf like Hedera or Laurus; in the case of such plants, where a leaf is shaded by two leaves, respiration commonly exceeds synthesis. The synthethic energy of the second leaf varies, according to differences in amount of chlorophyll and chlorenchyma, and to undetermined factors (probably specific chlorophyll differences), between one-half and one-forty-eighth of that in the leaf which receives unmodified solar rays. In diffuse light the synthethic energy of the second leaf is of course still less. To summarize, respiration generally exceeds synthesis where light has traversed two leaves in the sunlight or one leaf in the shade.

Linsbauer [39] has investigated the transparency of a number of leaves with the use of Wiesner's photometric methods. Only the more refrangible rays were studied. Leaves vary widely in the amount of light that they transmit, sun leaves of Cytisus and Cornus transmitting only 0.0003 of the light offered them, while shade leaves of Fagus transmit 0.02. In general, shade leaves transmit much more light than do sun leaves. The same species and even the same leaf (as N. J. C. Müller showed) shows wide variations, the shade leaf of Cornus transmitting seven times as much light as the sun leaf; perhaps these differences are due in part to variations in the amount of the

[36] Rev. Gen. Bot. **12**: 209–223, 272–288. 1900.

[37] BOT. GAZ. **27**: 491. 1899.

[38] Comp. Rend. **126**: 1583–1586. 1898.

[39] Bot. Centralb. Beihefte **10**: 53–89. 1901.

products of synthesis which are present. The white portions of variegated leaves absorb much more light than does the chlorophyll alone.

Reference has been made previously[40] to the work of Goldflus who found an amount of synthethic energy in the chlorophyll layer underneath the cork of trees that is surprising in the light of the experiments of Griffon and Linsbauer, as noted above.— H. C. COWLES.

ONION smut[41] and grape rots[42] are the subjects of two bulletins from the Ohio Experiment Station. The smut of the onion is able to penetrate the young plant only while leaving the seed or very soon thereafter. As it has no effect upon the sets, it is perfectly safe to put the latter into an infected field, if they have been grown in a seed bed free from smut spores. In certain parts of Ohio where growing sets from seeds is practiced, the loss from smut has amounted to 25 to 40 per cent., and even more, *i. e.*, to 100 to 200 or more bushels of sets per acre. Preliminary experiments go to show that by sprinkling the seeds, after they are scattered in the rows, with a solution of 1 oz. of 40 per cent. formalin in 2 to 3 gallons of water, until well moistened, and then covering with earth, the loss from smut is very greatly diminished. Ground burnt lime applied in the usual manner at a rate of 150 bushels per acre is also recommended as worthy of trial. Further experiments are to be undertaken to determine the commercial value of these treatments.

The grape rots causing the most damage in Ohio are white rot (*Coniothyrium diplodiella*) and black rot (*Laestedia bidwellii*). The former seems not to have been well distinguished from the latter, which may account for the paucity of the literature on the subject. It is less amenable to treatment, possibly from the fact that it is at its maximum almost immediately preceding ripening of the grapes, at a time when Bordeaux mixture and the more permanent fungicides cannot be used for fear of decreasing the market value of the fruit. It is only by constant spraying, beginning before the flower buds open, and continuing as close to the maturity of the grapes as possible, at least eight or nine sprayings a season, that the best results can be obtained in the grape regions of Ohio.— ERNST A. BESSEY.

[40] BOT. GAZ. **31**: 440. 1901.

[41] SELBY, A. D.: Onion smut. Preliminary experiments. Bull. Ohio Agr. Expt. Sta. 122: 71–84. *figs. 1–4.* December 1900. Wooster.

[42] ——— and HICKS, J. F.: Grape rots in Ohio, Experiments in the prevention of grape rot. *ibid.* 123: pp. 85–102. *figs. 1–3.* January 1901.